

We claim:

1. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and

5 opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

10 a plurality of fan blades coupled to the plate and extending toward the back wall,

each blade having a peripheral edge at least partially defining a heel

portion located a radial distance from the axis, a tip portion located a

greater radial distance from the axis, and a point positioned a maximum

axial distance from the plate, the point axially separated from the back

15 wall of the housing by a first distance no greater than about 0.5 inches.

2. The fan as claimed in claim 1, wherein a portion of the back wall adjacent the fan blades has a cross-sectional shape substantially similar to a peripheral shape of each fan blade.

20 3. The fan as claimed in claim 1, wherein the first distance is no greater than about 0.45 inches.

4. The fan as claimed in claim 1, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and
25 extending toward the inlet wall.

5. The fan as claimed in claim 4, wherein each of the second plurality of fan blades is curved and has a non-constant radius of curvature.

30

6. The fan as claimed in claim 3, wherein:
at least a portion of the back wall and at least a portion of the fan blades are located at a
common axial position; and
the at least a portion of the back wall is radially spaced from the at least a portion of the
fan blades by a second distance no greater than about 0.5 inches.

7. The fan as claimed in claim 6, wherein the second distance is no greater than about 0.45
inches.

8. The fan as claimed in claim 1, wherein:
at least a portion of the back wall and at least a portion of the fan blades are located at a
common axial position; and
the at least a portion of the back wall is radially spaced from the at least a portion of the
fan blades by a second distance no greater than about 0.5 inches.

9. The fan as claimed in claim 8, wherein the second distance is no greater than about 0.45
inches.

10. The fan as claimed in claim 1, wherein:
the plate is non-planar, and has a varying axial position with increasing radial
distance from the axis;
at least a portion of the plate defines an angle of expansion with respect to a plane
orthogonal to the axis; and
the angle of expansion is greater than about 0 degrees and is less than about 25 degrees.

11. The fan as claimed in claim 10, wherein the angle of expansion is greater than about 0
degrees and is less than about 20 degrees.

12. The fan as claimed in claim 3, wherein:
the plate is non-planar, and has a varying axial position with increasing radial
distance from the axis;
at least a portion of the plate defines an angle of expansion with respect to a plane
orthogonal to the axis; and
the angle of expansion is greater than about 0 degrees and is less than about 25 degrees.

13. The fan as claimed in claim 12, wherein the angle of expansion is greater than about 0
degrees and is less than about 20 degrees.

14. A centrifugal fan, comprising:
a housing comprising an inlet wall and a back wall spaced axially away from and
opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the
housing; and
an impeller contained at least partially within the housing and rotatable about an axis with
respect to the housing, the impeller comprising
a plate extending radially away from the axis; and
a plurality of fan blades coupled to the plate and extending toward the back wall,
each blade having a peripheral edge at least partially defining a heel
portion located a radial distance from the axis and a tip portion located a
greater radial distance from the axis,
wherein at least a portion of the back wall and at least a portion of the fan blades
are located at a common axial position and are radially spaced from each
other by a distance no greater than about 0.5 inches.

15. The fan as claimed in claim 14, wherein a portion of the back wall adjacent the fan blades
has a cross-sectional shape substantially similar to a peripheral shape of each fan blade.

16. The fan as claimed in claim 14, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the inlet wall.

5 17. The fan as claimed in claim 16, wherein each of the second plurality of fan blades is curved and has a non-constant radius of curvature.

18. The fan as claimed in claim 14, wherein the distance is no greater than about 0.45 inches.

10 19. The fan as claimed in claim 14, wherein:
the plate is non-planar, and has a varying axial position with increasing radial
distance from the axis;
at least a portion of the plate defines an angle of expansion with respect to a plane
orthogonal to the axis; and
15 the angle of expansion is greater than about 0 degrees and is less than about 25 degrees.

20. The fan as claimed in claim 19, wherein the angle of expansion is greater than about 0 degrees and is less than about 20 degrees.

20 21. The fan as claimed in claim 18, wherein:
the plate is non-planar, and has a varying axial position with increasing radial
distance from the axis;
at least a portion of the plate defines an angle of expansion with respect to a plane
orthogonal to the axis; and
25 the angle of expansion is greater than about 0 degrees and is less than about 25 degrees.

22. The fan as claimed in claim 21, wherein the angle of expansion is greater than about 0 degrees and is less than about 20 degrees.

30

23. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end and located a greater radial distance from the axis than the heel end; and

an intake angle defined between the chord of the fan blade and a straight line extending tangentially from the heel end of the fan blade, the

intake angle being no less than about 20 degrees and no greater than about 50 degrees,

wherein the plate is non-planar, and has a varying axial position with increasing

radial distance from the axis, at least a portion of the plate defining an angle of expansion with respect to a plane orthogonal to the axis, the

the angle of expansion being greater than about 0 degrees and less than about 25 degrees.

24. The fan as claimed in claim 23, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and

extending toward the back wall.

25. The fan as claimed in claim 23, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

26. The fan as claimed in claim 23, wherein the intake angle is no less than about 27 degrees and is no greater than about 45 degrees.

27. The fan as claimed in claim 23, wherein:

the tip ends of the fan blades trace an imaginary circle about the axis upon rotation of the impeller; and

each fan blade further comprises an exit angle defined between a line tangent to the imaginary circle at the tip end of the fan blade and a straight line extending tangentially from the tip end of the fan blade, the exit angle being no less than about 35 degrees and no greater than about 60 degrees.

28. The fan as claimed in claim 27, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

29. The fan as claimed in claim 23, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees.

30. The fan as claimed in claim 23, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

31. The fan as claimed in claim 23, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

32. The fan as claimed in claim 23, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

33. The fan as claimed in claim 23, wherein the angle of expansion is less than about 20 degrees.

34. The fan as claimed in claim 33, wherein the intake angle is no less than about 27 degrees and is no greater than about 45 degrees.

35. The fan as claimed in claim 33, wherein:

the tip ends of the fan blades trace an imaginary circle about the axis upon rotation of the impeller; and

each fan blade further comprises an exit angle defined between a line tangent to the imaginary circle at the tip end of the fan blade and a straight line extending tangentially from the tip end of the fan blade, the exit angle being no less than about 35 degrees and no greater than about 60 degrees.

36. The fan as claimed in claim 35, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

37. The fan as claimed in claim 33, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees.

38. The fan as claimed in claim 33, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

39. The fan as claimed in claim 33, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

40. The fan as claimed in claim 33, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

41. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end, located a greater radial distance from the axis than the heel end, and tracing an imaginary circle about the axis upon rotation of the impeller; and

an exit angle defined between a line tangent to the imaginary circle at the tip end of the fan blade and a straight line extending tangentially from the tip end of the fan blade, the exit angle being no less than about 35 degrees and no greater than about 60 degrees,

wherein the plate is non-planar, and has a varying axial position with increasing radial distance from the axis, at least a portion of the plate defining an angle of expansion with respect to a plane orthogonal to the axis, the angle of expansion being greater than about 0 degrees and less than about 25 degrees.

42. The fan as claimed in claim 41, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

43. The fan as claimed in claim 41, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

44. The fan as claimed in claim 41, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

45. The fan as claimed in claim 41, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees.

46. The fan as claimed in claim 41, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

47. The fan as claimed in claim 41, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

48. The fan as claimed in claim 41, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

49. The fan as claimed in claim 41, wherein the angle of expansion is less than about 20 degrees.

50. The fan as claimed in claim 49, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

51. The fan as claimed in claim 49, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees.

52. The fan as claimed in claim 49, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

53. The fan as claimed in claim 49, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

5 54. The fan as claimed in claim 49, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

55. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and

10 opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

15 a plurality of fan blades on the plate, each fan blade comprising a chord;

a heel end; and

a tip end opposite the heel end and located a greater radial distance from the axis than the heel end, wherein an angle between the chord of the fan blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees,

20 wherein the plate is non-planar, and has a varying axial position with increasing radial distance from the axis, at least a portion of the plate defining an angle of expansion with respect to a plane orthogonal to the axis, the angle of expansion being greater than about 0 degrees and less than about 25 degrees.

25

56. The fan as claimed in claim 55, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

5 57. The fan as claimed in claim 55, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

58. The fan as claimed in claim 55, wherein the angle between the chord and the straight line is no less than about 10 degrees and is no greater than about 25 degrees.

10

59. The fan as claimed in claim 55, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

60. The fan as claimed in claim 55, wherein each fan blade has a camber to chord ratio of no
15 less than about 10% and no greater than about 20%.

61. The fan as claimed in claim 55, wherein the angle of expansion is less than about 20 degrees.

20 62. The fan as claimed in claim 61, wherein the angle between the chord and the straight line is no less than about 10 degrees and is no greater than about 25 degrees.

63. The fan as claimed in claim 61, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

25

64. The fan as claimed in claim 61, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

30

65. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end; and

a tip end opposite the heel end and located a greater radial distance from the axis than the heel end, wherein the fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%,

wherein the plate is non-planar, and has a varying axial position with increasing radial distance from the axis, at least a portion of the plate defining an angle of expansion with respect to a plane orthogonal to the axis, the angle of expansion being greater than about 0 degrees and less than about 25 degrees.

66. The fan as claimed in claim 65, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

67. The fan as claimed in claim 65, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

68. The fan as claimed in claim 65, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

69. The fan as claimed in claim 65, wherein the angle of expansion is less than about 20 degrees.

70. The fan as claimed in claim 69, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

71. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end, located a greater radial distance from the axis than the heel end, and tracing an imaginary circle about the axis upon rotation of the impeller;

an intake angle defined between the chord of the fan blade and a straight line extending tangentially from the heel end of the fan blade, the intake angle being no less than about 20 degrees and no greater than about 50 degrees, and

an exit angle defined between a line tangent to the imaginary circle at the tip end of the fan blade and a straight line extending tangentially from the tip end of the fan blade, the exit angle being no less than about 35 degrees and no greater than about 60 degrees.

72. The fan as claimed in claim 71, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

5 73. The fan as claimed in claim 71, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

74. The fan as claimed in claim 71, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

10

75. The fan as claimed in claim 71, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees.

15 76. The fan as claimed in claim 71, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

20 77. The fan as claimed in claim 71, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

78. The fan as claimed in claim 71, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

25 79. The fan as claimed in claim 71, wherein the intake angle is no less than about 27 degrees and is no greater than about 45 degrees.

80. The fan as claimed in claim 79, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

30

81. The fan as claimed in claim 79, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees.

5 82. The fan as claimed in claim 79, wherein an angle between the chord of each blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

83. The fan as claimed in claim 79, wherein each fan blade has a camber to chord ratio of no
10 less than about 5% and no greater than about 20%.

84. The fan as claimed in claim 79, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

85. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end and located a greater radial distance from the axis than the heel end, wherein an angle between the chord of the fan blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees; and

an intake angle defined between the chord of the fan blade and a straight line extending tangentially from the heel end of the fan blade, the intake angle being no less than about 20 degrees and no greater than about 50 degrees.

86. The fan as claimed in claim 85, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

87. The fan as claimed in claim 85, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

88. The fan as claimed in claim 85, wherein the angle between the chord and the straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

89. The fan as claimed in claim 85, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

5 90. The fan as claimed in claim 85, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

91. The fan as claimed in claim 85, wherein the intake angle is no less than about 27 degrees and is no greater than about 45 degrees.

10

92. The fan as claimed in claim 91, wherein the angle between the chord and the straight line extending from the axis to the tip end of the fan blade is no less than about 10 degrees and is no greater than about 25 degrees.

15 93. The fan as claimed in claim 91, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

94. The fan as claimed in claim 91, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

95. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

5 an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

10 a heel end;

a tip end opposite the heel end and located a greater radial distance from the axis than the heel end;

an intake angle defined between the chord of the fan blade and a straight line extending tangentially from the heel end of the fan blade, the

15 intake angle being no less than about 20 degrees and no greater than about 50 degrees; and

a camber to chord ratio of no less than about 5% and no greater than about 20%.

20 96. The fan as claimed in claim 95, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

25 97. The fan as claimed in claim 95, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

98. The fan as claimed in claim 95, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

99. The fan as claimed in claim 95, wherein the intake angle is no less than about 27 degrees and is no greater than about 45 degrees.

100. The fan as claimed in claim 99, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

101. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end, located a greater radial distance from

the axis than the heel end, and tracing an imaginary circle about the

axis upon rotation of the impeller, wherein an angle between the

chord of the fan blade and a straight line extending from the axis to

the tip end of the fan blade is no less than about 5 degrees and is no greater than about 30 degrees; and

an exit angle defined between a line tangent to the imaginary circle at the

tip end of the fan blade and a straight line extending tangentially

from the tip end of the fan blade, the exit angle being no less than

about 35 degrees and no greater than about 60 degrees.

102. The fan as claimed in claim 101, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

103. The fan as claimed in claim 101, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

5 104. The fan as claimed in claim 101, wherein the angle between the chord and the straight line is no less than about 10 degrees and is no greater than about 25 degrees.

105. The fan as claimed in claim 101, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

10

106. The fan as claimed in claim 101, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

107. The fan as claimed in claim 101, wherein the exit angle is no less than about 40 degrees
15 and is no greater than about 55 degrees.

108. The fan as claimed in claim 107, wherein the angle between the chord and the straight line is no less than about 10 degrees and is no greater than about 25 degrees.

20 109. The fan as claimed in claim 107, wherein each fan blade has a camber to chord ratio of no less than about 5% and no greater than about 20%.

110. The fan as claimed in claim 107, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

111. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and

opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end, located a greater radial distance from the axis than the heel end, and tracing an imaginary circle about the axis upon rotation of the impeller;

an exit angle defined between a line tangent to the imaginary circle at the tip end of the fan blade and a straight line extending tangentially from the tip end of the fan blade, the exit angle being no less than about 35 degrees and no greater than about 60 degrees; and

a camber to chord ratio of no less than about 5% and no greater than about 20%.

112. The fan as claimed in claim 111, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

113. The fan as claimed in claim 111, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

114. The fan as claimed in claim 111, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

115. The fan as claimed in claim 111, wherein the exit angle is no less than about 40 degrees and is no greater than about 55 degrees.

116. The fan as claimed in claim 115, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

117. A centrifugal fan, comprising:

a housing comprising an inlet wall and a back wall spaced axially away from and opposite the inlet wall, the inlet wall having an aperture to allow gases to enter the housing; and

an impeller contained at least partially within the housing and rotatable about an axis with respect to the housing, the impeller comprising

a plate extending radially away from the axis; and

a plurality of fan blades on the plate, each fan blade comprising

a chord;

a heel end;

a tip end opposite the heel end and located a greater radial distance from the axis than the heel end, wherein an angle between the chord of

the fan blade and a straight line extending from the axis to the tip end of the fan blade is no less than about 5 degrees and is no

greater than about 30 degrees; and

a camber to chord ratio of no less than about 5% and no greater than about 20%.

118. The fan as claimed in claim 117, wherein the plurality of fan blades is a first plurality of fan blades, the fan further comprising a second plurality of fan blades coupled to the plate and extending toward the back wall.

119. The fan as claimed in claim 117, wherein each of the plurality of fan blades is curved and has a non-constant radius of curvature.

120. The fan as claimed in claim 117, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

5 121. The fan as claimed in claim 117, wherein the angle between the chord and the straight line is no less than about 10 degrees and is no greater than about 25 degrees.

122. The fan as claimed in claim 121, wherein each fan blade has a camber to chord ratio of no less than about 10% and no greater than about 20%.

10